

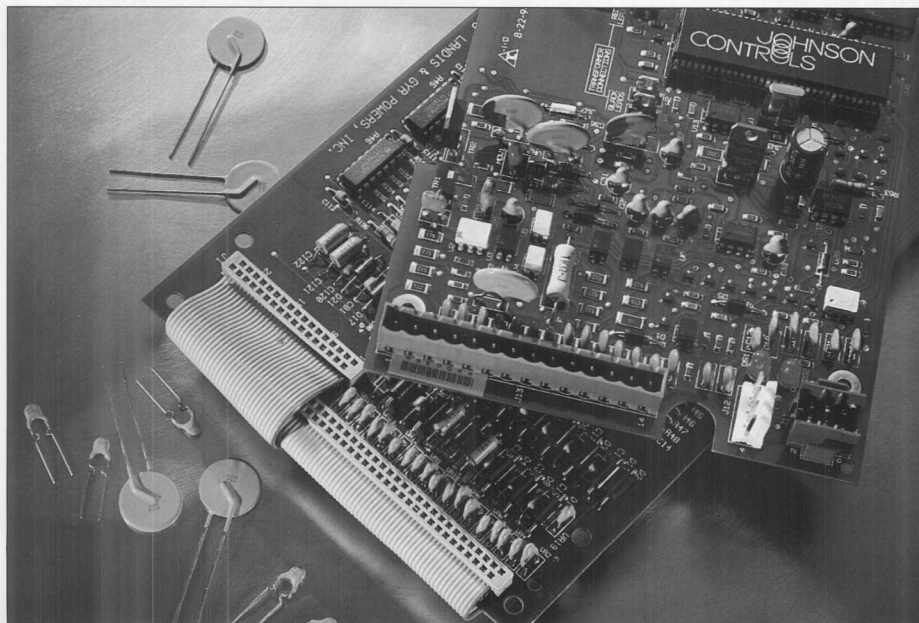
Resettable Protection from Raychem PolySwitch Resettable Fuses

The continuing automation of industrial processes makes remote monitoring and control increasingly important. Modern installations demand the use of control systems that guarantee accurate communications, not only between different decision centers and machines, but throughout an installation.

The Complexity of the Problem

Remote monitoring and control systems are inherently complex, and present designers with several potential problem areas. Installers, for example, can inadvertently short circuit power lines, or a cable can be pinched when it is installed in a conduit. A fault condition can also arise from the installation of an incorrectly wired cable that connects the wrong power source to the wrong load.

If the current that results from these kinds of faults is high enough, wiring can overheat, components can fail, and circuit board traces can burn. This may lead to extensive damage of expensive equipment and the loss of a critical system for an extended period. Critical circuits must be protected against overcurrent conditions.



Raychem PolySwitch resettable fuses.

Resettable Fuse

A PolySwitch resettable fuse solves the problems associated with protection of industrial process controls. This self-resetting protection device is made from a blend of specially formulated polymers and conductive materials. In its normal state, the conductive materials within a resettable fuse form conductive chains through the body of the polymer. As a result, the device's normal resistance is so low, typically tenths of milliohms, that the resistance has no effect on the protected circuit's operation.

If the current rises above the trip threshold of the resettable fuse, heat generated by the increased current raises the internal temperature, which causes the conductive chains to separate. As they separate, the resistance rapidly increases by several decades. This action quickly reduces the circuit current to very low levels. Even so, the tripped current is sufficient to maintain the internal temperature of the resettable fuse high enough to prevent the conductive chains from reforming.

Continued separation of the conductive chains latches the device into its tripped state. However, when circuit power is removed, the device cools and the conductive chains reform, lowering the resistance to its normal value. In this way, a fuse automatically resets itself. When the fault condition causing the overcurrent condition is corrected and power is restored, the circuit functions normally.

Benefits of PolySwitch Resettable Fuses

When communications over several hundreds or thousands of feet are required, they are often handled through a serial RS-485 twisted-pair transmission link that can connect the host to several monitor sites. The

systems. The MC33164/34164 microprocessor undervoltage sensing circuit is a stand-alone reset generator. Portable computing requires a battery charger and switching regulator circuits. The MC3334x series products provide precise control on output voltage and current while the MC3336x series provides eight 45 W power supply controls.

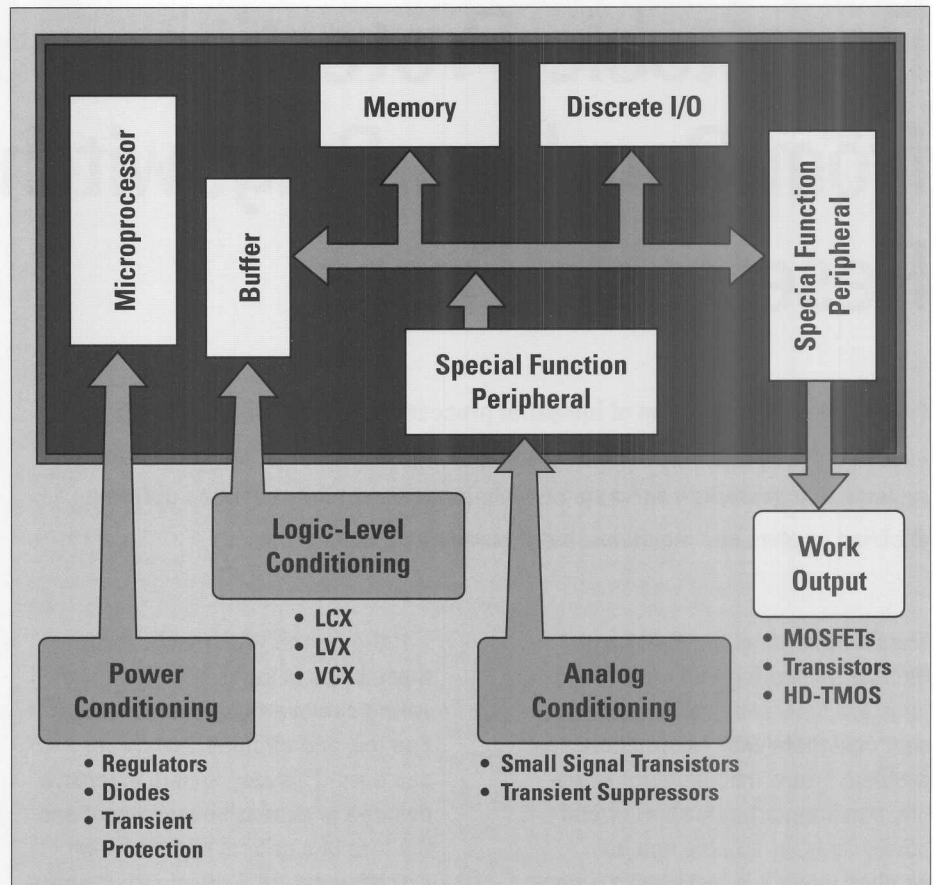
Battery-operated systems can take advantage of the MC33502, the industry's first true 1 V op amp. This op amp has a unique design allowing for rail-to-rail operation at the input and output below 1 V.

Logic-Level Conditioning

Motorola's low voltage CMOS logic (LVX) can be the solution for the 5 V-in, 3 V-out system design. Motorola's LCX is a logic-level family specifically designed for 2.7 to 3.6 V operation. MC74LVX easily accommodates mixed 3 and 5 V systems with low power and low switch noise. The VCX family is the fastest 2.5 V CMOS logic-level performer and is voltage compatible with 3.6 and 1.8 V supply specifications.

Work Output

WaveFET™, Motorola's newest family of advanced technology power MOSFETs, has better avalanche capability, improved switching speeds, and low $R_{DS(on)}$ in an S08 package. MiniMOS™ power FETs are separated into three families of devices, designed for operation at 3.3, 5, and 12 V systems over four voltage ranges, (12, 20, 30, and 40 V), and feature extremely low $R_{DS(on)}$ for higher efficiency. For lower cost bi-directional blocking and short-circuit limiting, use bi-polar junction transistors in Motorola's MMJT and MMDS series. The new E series IGBT with UFS (ultra fast and soft recovery) from Motorola features exceptionally clean



Embedded systems rely on a number of devices.

and smooth behavior which reduces noise and extends the life of the motor. For those power switching functions that need low VDD overshoot (less than 15 percent at 400 V) and a path back to a power source from an inductive load, IGBTs and fast recovery diodes are available in the same package.

Analog Conditioning

Protection from lightning, switching surges, and electrostatic discharge (up to 600 watts at a rate of one millisecond) is the key feature of the 1 SMB series.

Embedded systems require more than DSPs and microprocessors in order to function. In fact, in most applications the total value of the support chips in the applications exceeds

the ASP of the control chip. Motorola's component chip solutions make all the devices work together economically.

For more information on Motorola's Component Chip Solutions, check Reader Service No. 2.

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RS-485 drive includes a differential voltage of +5 V. Since the distance covered can be quite long, miswiring and short circuits are not unusual. To prevent damage, overload protection is essential. As shown in Figure 1, the proper protection scheme can come from a zener diode and a small resettable fuse such as the RXE010. Circuit protection would be placed immediately after the interface to the printed circuit board and before the transceiver for the twisted pair.

An additional benefit of the PolySwitch device is the ability to downsize other protection devices. A transorb or zener diode, acting as a voltage clamp on a 5 V signal line, protects the circuit by creating a very low-resistance path-to-ground if the voltage on the protected line exceeds its breakdown voltage. However, since significant current can flow through the device, it must be large enough to handle the maximum anticipated current flow under worst-case conditions. If a resettable fuse is used to limit the current that flows through the clamping device, the zener diode will not have to dissipate as much power and may therefore be much smaller and less expensive.

It is not uncommon in a given process control architecture to change the range for the process variables. This change can be accomplished by downloading the parameters to the monitors through the RS-232 connection. The RS-232 link is also used to verify calibration between the monitor and the host. Either application requires the use of external equipment to the host's RS-232 port. The RS-232 drive includes a low-current ± 12 V signal. If an incorrectly wired cable is used or pins are accidentally shorted, damage can quickly occur. A strategy similar to that used for the RS-465 port can provide reliable protection, but it

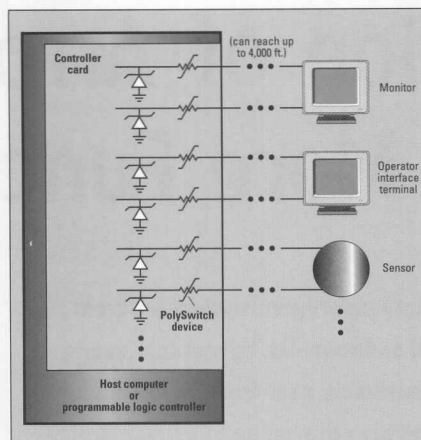


Figure 1: RS-485 signal with protection.

requires the use of back-to-back zener diodes to accommodate the drive voltage.

Control Circuits

When a process variable is out of its specified range, the host can instruct control circuits to correct the problem by turning a motor on, energizing a solenoid, closing a valve, or taking some other appropriate action. Each action, however, requires some type of switching. Today, most switching is solid-state and often performed by a silicon-controlled rectifier (SCR).

An SCR can be turned on in the forward direction by the application of a low-voltage control signal to its gate. Although a robust device, if incorrectly wired or connected to a malfunctioning load, the SCR can overheat and fail. This potential hazard and its consequences can be eliminated by connecting a resettable fuse in series with the SCR. If the load out in the field fails, the device will trip before the SCR on the board fails, which eliminates the need for replacing the SCR.

Electromechanical Relays

Still used in some process control equipment, electromechanical relays are not immune from potentially dam-

aging overcurrent faults. For example, if the load in the field fails or shorts, contacts may become welded shut and fail. The problem can be avoided by using a resettable fuse which will trip to its high-resistance state should the load in the field fail.

Alternative Solutions

Fuses and ceramic positive temperature coefficient (CPTC) resistors have been used to limit current in remote monitoring and control systems. However, neither method meets the needs of many applications.

If a circuit experiences a transient current, it is possible that the fuse could blow open inadvertently. Fuses are one-time devices that must be replaced when they open. PolySwitch devices will typically not trip during a transient current.

Ceramic PTC resistors have a relatively high resistance under normal operating conditions and can dissipate noticeable power. On the other hand, PolySwitch devices employ low resistive materials that keep the steady-state power dissipation at a minimum.

PolySwitch devices provide excellent circuit protection for process and industrial control systems. Their reset ability and latching features plus their economical cost, simplicity, and increased system reliability make them well suited for many applications.

For a Raychem PolySwitch Resettable Fuse literature packet, check Reader Service No. 3.

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